**Title:** METHOD FOR FEEDING AN ELECTRIC FENCE AND A PULSE GENERATOR FOR CARRYING OUT THE METHOD

![Diagram](Diagram.png)

**Abstract**

In a method for feeding an electric fence, use is made of a rechargeable charge storage unit (3') and a transformer (6') having a primary winding (16, 18) through which the charge storage unit (3') is dischargeable, and having a secondary winding (8) to which the electric fence (9) is connected. A pulse generator for carrying out the method has a load detector (10) which is arranged to determine the load on the secondary winding (8) of the transformer (6') for each pulse generated therein by the discharge of the charge storage unit (3'), and a trigger circuit (4) controlled by the load detector (10). The trigger circuit is arranged to control the charge storage unit (3') so as to supply additional energy to the same pulse if the load exceeds a predetermined load value.
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METHOD FOR FEEDING AN ELECTRIC FENCE AND A PULSE GENERATOR FOR CARRYING OUT THE METHOD

The present invention relates to a method for feeding an electric fence by means of a rechargeable charge storage unit and a transformer having a primary winding through which the charge storage device is dischargeable, and a secondary winding to which the electric fence is connected. The invention also relates to a pulse generator for carrying out the method.

Electric fences are used to prevent animals from leaving a fenced area. Pulse generators for electric fences may be connected to the mains or be battery-powered. The demands that the user, the farmer, places on a pulse generator is that it should be reliable, maintenance-free and consume little energy in the case of a battery-powered pulse generator. According to regulations set by the authorities, pulse generators must not emit such current or voltage as may cause damage to people or be a fire hazard.

To produce a sufficient shock effect, when touching the electric fence, to have the animals avoid the fence, the pulse generator should have a high power output, also causing drying of growing grass which would otherwise bring about undesired ground contact. According to the safety regulations in most countries, the power output is however maximized, generally to 5 J at a load of 500 ohm, while a power limit below this load value is seldom set.

The object of the present invention is to provide a method for feeding an electric fence of the type stated in the introduction to this specification, and to a pulse generator for carrying out the method, the method and the pulse generator making it possible to produce a sufficient shock effect independently of the load of the pulse generator.
In the method stated by way of introduction, this object is achieved by determining the load on the secondary winding of the transformer for each pulse generated by the discharge of the charge storage unit, and by controlling the charge storage unit so as to supply additional energy to the same pulse if the load exceeds a predetermined load value.

The inventive object is further achieved by the pulse generator being characterized by having a load detector arranged to determine the load on the secondary winding of the transformer for each pulse generated therein by the discharge of the charge storage unit, and a trigger circuit controlled by the load detector and arranged to control the charge storage unit so as to supply additional energy to the same pulse if the load exceeds a predetermined load value.

As appears from the foregoing, the predetermined load value generally is 500 ohm.

The invention ensures automatic adjustment of the power output according to the load on the fence, more particularly in such a manner that the maximum power output stipulated by the authorities for the predetermined load value is emitted precisely at this predetermined load value, whereby the shock effect at the predetermined load value and at lower load values becomes sufficient while, at loads above the predetermined load value, the required shock effect is obtained by increasing the power output for each separate pulse.

The inventive concept yields a number of advantages, such as reduced power consumption and, thus, increased battery life in the case of a battery-powered pulse generator. The change of the power output is readily adaptable to current regulations in different countries and also involves the advantage of extending the life of the pulse generator.
According to the invention, the load on the secondary winding of the transformer is determined preferably on the basis of the maximum value of the voltage of the pulse generated in the secondary winding, and the pulse is supplied with additional energy if the maximum value falls below a predetermined value.

However, to avoid dependence on the recharging of the charge storage unit, it is provided according to the invention suitably to determine the load on the secondary winding of the transformer on the basis of the difference between the maximum value of the voltage of the pulse generated in the secondary winding and a value representing the current of the pulse at a corresponding point of time, the additional energy being supplied if said difference is negative.

To avoid the supply of additional energy if the load is capacitive, the phase difference between the voltage and the current of the pulse is suitably determined.

The pulse generator according to the invention more particularly has a load detector arranged to determine the load on the secondary winding of the transformer for each pulse generated therein by the discharge of the charge storage unit, and a trigger circuit controlled by the load detector and arranged to control the charge storage unit so as to supply additional energy to the same pulse if the load exceeds a predetermined load value.

The load detector suitably comprises a voltage level detector for determining the load on the basis of the maximum value of the voltage of the pulse generated in the secondary winding, the trigger circuit being arranged to control the charge storage unit so as to supply the additional energy to the same pulse if the maximum value falls below a predetermined value.
The transformer suitably has a sensing winding connected to the voltage level detector and producing a pulse proportional to the voltage of the pulse in the secondary winding.

The load detector further suitably has a current level detector producing an output signal proportional to the current of the pulse in the secondary winding, said load detector being arranged to determine the load on the basis of the difference between the output signal of the voltage level detector and the output signal of the current level detector, and the additional energy being supplied if said difference is negative.

The charge storage device may suitably comprise two or more capacitors which are dischargeable each by a thyristor switch, one of said capacitors giving rise to the pulse in the secondary winding when closing the associated thyristor switch, and another of said capacitors giving rise to the supply of additional energy by the trigger circuit closing the associated thyristor switch.

The invention will now be described in more detail hereinbelow with reference to the accompanying drawings. Fig. 1 is a circuit diagram for a conventional pulse generator for use in an electric fence. Fig. 2 is a schematic diagram for a pulse generator according to the invention for use in an electric fence. Fig. 3 illustrates an embodiment of the charge storage device in a pulse generator according to the invention for use in an electric fence. Fig. 4 is a circuit diagram for a preferred embodiment of the load detector and the trigger circuit in a pulse generator according to the invention for use in an electric fence. Fig. 5 shows an example of pulses from the pulse generator according to the invention.

The conventional pulse generator shown in Fig. 1 for use in an electric fence consists of a charging
unit 1 by means of which a capacitor 2 in a charge
storage unit 3 can be charged. Via a thyristor 5 con-
trolled by a trigger circuit 4, the capacitor 2 is
repetitively dischargeable through the primary winding
7 of a transformer 6. The secondary winding 8 of the
transformer 6 is connected both to the wire 9 of the
electric fence and to ground. In some cases, a voltage
limiter (not shown) may be connected between the sec-
dary winding 8 of the transformer 6 and the electric
fence.

The charging unit 1 may be battery-powdered or
connected to the mains and generally charges the capa-
citor 2 to a voltage of about 600 V. The trigger cir-
cuit 4 supplies ignition pulses to the thyristor 5
at a predetermined repetition frequency, e.g. at time
intervals of about 1 s.

The amount of energy supplied by the conventional
pulse generator is constant and independent of the
load of the electric fence on the transformer 6. If
the load is high, i.e. the resistance between the
electric fence wire and the ground is low, there is
thus obtained a pulse of relatively low voltage on
the fence wire while, when the load is low, the pulse
will have comparatively higher voltage.

The pulse generator according to the invention
shown in Fig. 2 has a dynamic load detector 10 arranged
for each emitted pulse to determine the load on the
secondary winding 8 of the transformer 6 and, when
the load exceeds a predetermined value, to supply
additional energy to the same pulse and, thus, increase
the voltage on the fence wire. The predetermined load
value may correspond, for instance, to a resistance
of 500 ohm.

The load can be determined by determining the
voltage of the pulse at a certain point of time, e.g.
its maximum, presupposing however constant charging
of the charge storage unit. In order to make the load
determination independent of the charging of the capacitor, it is advantageously made on the basis of the relationship between the voltage and the current of the pulse at a certain point of time, e.g. at the time of the maximum value of the voltage.

The charge storage unit 3' according to the invention shown in Fig. 3 has two capacitors 11, 12 which, each via a diode 13 and 14, respectively, can be charged from the charging unit 1 (not shown). The capacitor 11 is connected in series with a thyristor 15 through a first primary winding 16 of the transformer 6' while the capacitor 12 is connected in series with a second thyristor 17 through a second primary winding 18 of the transformer 6'.

The transformer 6' has a further winding 19 serving as a sensing winding and connected to a first input of the load detector 10. A second input of the load detector 10 is connected through a conductor part 20 in the discharge path for the capacitor 11 in the charge storage unit 3'.

A pulse induced in the sensing winding 19 at the same time as the pulse in the secondary winding 8 is a reflexion of the pulse in the secondary winding in respect of its voltage. The current through the conductor part 20 upon discharge of the capacitor 11 is a measure of the charge of the capacitor 11 and also of the current accompanying the pulse induced in the secondary winding 8. From the signals on its two inputs, the load detector 10 can thus, by suitably weighting the input signals, determine the load on the secondary winding 8 of the transformer 6' for each pulse generated.

The mode of operation of the circuit in Fig. 3 is as follows. With the capacitors 11 and 12 charged, the trigger circuit 4 emits an ignition pulse to the thyristor 15, whereby the charge of the capacitor
11 is discharged through the primary winding 16 of the transformer 6', the thyristor 15 and the conductor part 20. The pulse induced in the secondary winding 8 is applied to the electric fence wire 9. During a first part of the pulse in the secondary winding 8, the load detector 10 determines the load of the secondary winding 9, more specifically whether this load exceeds or falls below a predetermined load value. If the load exceeds the predetermined load value, the load detector 10 controls the trigger circuit 4 so as to emit an ignition pulse to the thyristor 17, whereby the capacitor 12 is discharged through the second primary winding 18 of the transformer 6'. This results in the supply of additional energy to the pulse in the secondary winding 8 produced by the discharge of the capacitor 11, which takes place during the descending part of this pulse, the voltage of which can thus be considerably increased.

If the load of the load detector 10 is however established as being below the predetermined load value, the trigger circuit 4 emits no ignition pulse to the thyristor 17, and the capacitor 12 is not discharged. The diodes 13 and 14 isolate the capacitors 11 and 12 from each other, such that no renewed charging of the capacitor 12 is required in this case before the emission of the next pulse to the electric fence wire 9.

A preferred embodiment of the trigger circuit 4 and the load detector 10 in Fig. 3 is shown in Fig. 4. The input of the load detector 10 connected to the sensing winding 19 constitutes the input of a first amplifier 21, and the input of the load detector 10 connected to the conductor part 20 constitutes the input of a second amplifier 22. These two amplifiers are suitably operational amplifiers of high input impedance. The output of the amplifier 21 is connected both to a derivation circuit 23 and to the negative
input of a comparator 24. The output of the amplifier 22 is connected both to a derivation circuit 25 and to the positive input of the comparator 24. The output of the comparator 24 is connected to the data input of a D-type flip-flop 26. The derivation circuit 23 is connected via a zero crossing detector 27 both to the clock input of the D-type flip-flop 26 and to the reset input of a counter 28. The derivation circuit 25 is connected via a zero crossing detector 29 to the clock input of a second D-type flip-flop 30. The set input of the D-type flip-flop 26 is connected to ground, its Q output is connected to the gate of the thyristor 17, and its reset input is connected to the Q̅ output of the flip-flop 30. The data input of the flip-flop 30 is connected to ground, its reset input is connected to the Q output of the flip-flop 26, and its set input is connected to an output from the counter 28, on which output a pulse appears for every 64 pulses on the input of the counter 28 which is supplied with a pulse train having a pulse frequency of 50 Hz. Said counter output is connected to the gate of the thyristor 15 and is connected via a diode 31 to the counter input.

The mode of operation of the circuit in Fig. 5 is as follows. When the counter 28 has counted 64 pulses, an ignition pulse is emitted to the thyristor 15, the operation of the counter 28 is interrupted, and the flip-flop 30 is set, i.e. its Q̅ output is "0". The input signals appearing by the ignition of the thyristor 15 on the amplifiers 21 and 22 are amplified thereby and compared in the comparator 24 whose output signal is "1" if the load on the secondary winding 8 of the transformer 6' exceeds the predetermined load value, and "0" if the load on the secondary winding 8 of the transformer 6' falls below the predetermined load value. The output signal of the amplifier 21 is derived by the derivation circuit 23, and the
zero crossing detector 27 emits a pulse to the clock input of the flip-flop 26 when the output signal from the derivation circuit 23 is zero, i.e. when the pulse in the sensing winding 19 and thus the pulse in the secondary winding 8 have a maximum voltage value.

If the output signal from the comparator 24 then is "1", an ignition pulse will be emitted to the thyristor 17, and the flip-flop 30 is at the same time reset and, in turn, resets the flip-flop 26. The clock pulse to the flip-flop 26 also resets the counter 28 which again starts counting the pulses in the pulse train on its input. However, if the output signal from the comparator 24 is "0", no ignition pulse is emitted to the thyristor 17, but the counter 28 is reset for a new pulse count.

When the load on the secondary winding of the transformer 6' is substantially resistive, the pulse on the output of the zero crossing detector 27 will appear before the pulse on the output of the zero crossing detector 29. This detector will reset the flip-flop 30 when the flip-flop 26 is not emitting any pulse on its Q output, and the flip-flop 30 in turn resets the flip-flop 26.

When the load on the secondary winding 8 of the transformer 6' is capacitive, the pulse on the output of the zero crossing detector 29 will however appear before the pulse on the output of the zero crossing detector 27. The flip-flop 30 will thus be reset and itself reset the flip-flop 26 before this receives its clock pulse. Thus, no ignition pulse is emitted to the thyristor 17, which is however not desirable in this case.

In Fig. 5, there are shown two pulses 32 and 33, the pulse 32 corresponding to the case where the load on the secondary winding 8 of the transformer 6 is below the predetermined load value, i.e. no additional energy is supplied, while the pulse 33 corresponds
to the case where the load is above the predetermined load value and, thus, additional energy is supplied to the same pulse on the basis of which the load determination has been made, more particularly in the descending part of the pulse. The total pulse time is not extended by this procedure and, hence, a considerable increase of the shock effect can be achieved by increasing the maximum value of the voltage of the pulse.

Several modifications of the embodiments described above are conceivable within the scope of the invention. If, for instance, the load can always be assumed to be resistive, the components 25, 29 and 30 can be dispensed with. Further, if the charging of the capacitors 11 and 12 can be made invariable, the amplifier 22 can also be cancelled, and the positive input of the comparator 24 can be connected to a constant reference potential. As an alternative to the charge storage unit 3' in Fig. 3, it is possible to use the unit according to Fig. 1 if the thyristor 5 is a quenchable thyristor.

In this latter case, the input signals of the comparator 24 may, for example, be changed, such that the flip-flop 26 on its Q output emits a quenching pulse to the thyristor 5 if the load on the secondary winding 8 of the transformer 6' falls below the predetermined load value. Further embodiments are evident to those skilled in the art.
CLAIMS

1. Method for feeding an electric fence by means of a rechargeable charge storage unit (3, 3') and a transformer (6, 6') having a primary winding (7, 16, 18) through which said charge storage unit (3, 3') is dischargeable, and a secondary winding (8) to which the electric fence (9) is connected, characterized in that the load on the secondary winding (8) of the transformer (6, 6') is determined for each pulse generated by the discharge of the charge storage unit (3, 3'), and that the charge storage unit is controlled so as to supply additional energy to the same pulse if the load exceeds a predetermined load value.

2. Method as claimed in claim 1, characterized in that said load is determined on the basis of the maximum value of the voltage of the pulse generated in the secondary winding (8), and that said additional energy is supplied if the maximum value falls below a predetermined value.

3. Method as claimed in claim 1, characterized in that said load is determined on the basis of the difference between the maximum value of the voltage of the pulse generated in the secondary winding (8) and a value representing the current of the pulse at a corresponding point of time, and that said additional energy is supplied if said difference is negative.

4. Method as claimed in any one of claims 1-3, characterized in that the phase difference between the voltage and the current of the pulse is determined, and that the supply of additional energy is inhibited if the load is capacitive.

5. Pulse generator for use in electric fences, comprising a rechargeable charge storage unit (3, 3')
and a transformer (6, 6') having a primary winding (7, 16, 18) through which said charge storage unit (3, 3') is dischargeable, and a secondary winding (8) to which the electric fence (9) is connected, characterized by a load detector (10) arranged to determine the load on the secondary winding (8) of the transformer (6, 6') for each pulse generated therein by the discharge of said charge storage unit (3, 3'), and a trigger circuit (4) controlled by said load detector (10) and arranged to control the load storage unit (3, 3') so as to supply additional energy to the same pulse if the load exceeds a predetermined load value.

6. Pulse generator as claimed in claim 5, characterized in that the load detector (10) comprises a voltage level detector (21, 23, 26, 27) for determining the load on the basis of the maximum value of the voltage of the pulse generated in the secondary winding (8), said trigger circuit (4) being arranged to control the charge storage unit (3, 3') so as to supply said additional energy if the maximum value falls below a predetermined value.

7. Pulse generator as claimed in claim 6, characterized in that the transformer (6') has a sensing winding (19) which is connected to the voltage level detector (21, 23, 26, 27) and generates a pulse proportional to the voltage in the secondary winding (8).

8. Pulse generator as claimed in claim 6 or 7, characterized in that the load detector (10) further has a current level detector (20, 22) generating an output signal proportional to the current of the pulse in the secondary winding (8), and that the load detector (10) is arranged to determine the load on the basis of the difference between the output signal of the voltage level detector (21, 23, 26, 27) and the output signal of the current level.
detector (20, 22), said trigger circuit (4) being arranged to control the charge storage unit (3, 3') so as to supply said additional energy if said difference is negative.

9. Pulse generator as claimed in any one of claims 5-7, characterized in that the charge storage unit (3') comprises two capacitors (11, 12) which are dischargeable each by means of a thyristor switch (15, 17) and of which the capacitor (11) gives rise to the pulse in the secondary winding (8) upon closure of the associated thyristor switch (15), and of which the second capacitor (12) gives rise to said supply of additional energy upon closure of the associated thyristor switch (17).

10. Pulse generator as claimed in any one of claims 5-9, characterized in that the load detector (10) also comprises a phase detector (30) for determining whether the load is capacitive and, in that case, prevents the supply of said additional energy.
INTERNATIONAL SEARCH REPORT

I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC

H 05 C 1/04

II. FIELDS SEARCHED

Minimum Documentation Searched *

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<td>Nat Cl</td>
<td>21d3:3/03, 21g7/02</td>
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<td>US Cl</td>
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT *

<table>
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<th>Citation of Document, with indication, where appropriate, of the relevant passages</th>
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<td>A</td>
<td>DE, C, 1 514 726 (SCHHECKER SEB.BLOCK) 1 February 1973</td>
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<td>DE, B, 2 438 582 (UTINA-ELEKTROWERK) 26 February 1976</td>
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"A" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search: 1988-08-10

Date of Mailing of this International Search Report: 1988-08-24

International Searching Authority: Swedish Patent Office

Signature of Authorized Officer: C-A. Lannefors

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